ARTICLE

Acute use of oxygen therapy

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SUMMARY

A major change is needed in the entrenched culture of routinely administering high-concentration oxygen to acutely ill patients regardless of need.

Oxygen is a drug that should be prescribed for specific indications. There should be a documented target range for oxygen saturation, and regular monitoring of the patient's response.

There are risks from unrelieved hypoxaemia due to insufficient oxygen therapy, and from provoked hyperoxaemia due to excessive oxygen therapy. Oxygen therapy should therefore be titrated so that the saturation is within a range that avoids these risks.

If oxygen requirements are increasing, the clinician should review the patient and consider transfer to a higher level of care. If oxygen requirements are decreasing, consider reducing or discontinuing oxygen therapy.

Introduction

Management of the acutely hypoxaemic patient requires evaluation and treatment of the underlying cause of the hypoxaemia. Oxygen therapy relieves hypoxaemia, but not the underlying cause.

Oxygen is a drug and it should be prescribed for specific indications. This prescription should include the target range for oxygen saturation. The response to oxygen administration requires regular monitoring.[1-3]

Identifying the need for oxygen

In the first assessment of an unwell patient, oxygen saturations can be determined by pulse oximetry. However, clinicians need to be aware that the accuracy of pulse oximetry is variable in clinical practice.[4] Arterial blood gases should be measured in patients who are critically unwell, when an oximetry reading cannot be obtained or when hypercapnia is suspected. In view of the widespread use of venous blood gas measurements, clinicians need to be aware that this method cannot accurately determine arterial carbon dioxide.[5]

Oxygen therapy is indicated in patients with oxygen saturations below the target saturation range. It is not indicated for the treatment of breathlessness in patients with adequate oxygen saturations, apart from certain patients with carbon monoxide poisoning and with pneumothorax.[3,6]

Prescribing the appropriate dose

Just like any other drug, oxygen should be prescribed at the appropriate dose, to achieve a desired outcome. For oxygen this is the designated saturation range. This approach is important because unrelieved hypoxaemia due to insufficient oxygen therapy, and provoked hyperoxaemia due to excessive oxygen therapy, are both associated with adverse clinical outcomes.[7-10]

Target oxygen saturation ranges

The recommended target saturation range should be included as part of the patient's oxygen prescription on the drug chart.

COPD and conditions associated with chronic respiratory failure

In the treatment of exacerbations of chronic obstructive pulmonary disease (COPD), oxygen should be titrated to achieve a target oxygen saturation range of 88–92%. This results in a greater than twofold reduction in mortality, compared with the routine administration of high-concentration oxygen therapy (see Box).[9]

Uncontrolled oxygen therapy for patients with COPD can cause hypercapnia. Due to concerns that the risks of high-concentration oxygen therapy may also apply in other conditions that place patients at risk of hypercapnic respiratory failure (cystic fibrosis, neuromuscular disorders, chest wall disorders, morbid obesity), the saturation target of 88–92% has also been recommended for these patients.[3]

Other acute medical conditions

Due to limited evidence from randomised controlled trials to guide clinical practice, it has been difficult to set a target saturation range for other acute medical conditions, such as asthma, pneumonia and acute coronary syndrome.[8,11-13] A pragmatic guide is to only

Box **Evidence for a target oxygen saturation of 88–92% in acute exacerbations of chronic obstructive pulmonary disease**[9]

In a randomised controlled trial, ambulances were allocated to treat patients having an acute exacerbation of chronic obstructive pulmonary disease with either:

- titrated oxygen therapy – oxygen delivered by nasal cannulae as required to achieve target pulse oximetry saturations of 88–92% and bronchodilators delivered by an air-driven nebuliser

or

- high-concentration oxygen therapy – 8 L/min via a non-rebreather mask, regardless of oxygen saturation, and bronchodilators given by an oxygen-driven nebuliser.

Key findings were:

- mortality was over two times higher in patients who received routine high-concentration oxygen compared with those who received titrated oxygen therapy
- the number needed to harm (death) with the routine use of high-concentration oxygen was 14 (one additional person died for every 14 treated).

give oxygen if saturations are under 92%, with a target saturation range of 92–96%.

Selecting the appropriate delivery method

Oxygen can be delivered through a number of devices (Table). For most patients, standard nasal cannulae are the preferred method of delivery. The flow rate is varied to achieve the target oxygen saturation.

Nebulisers

In patients with COPD, titration of oxygen therapy should continue during bronchodilator administration, if required, to achieve the 88–92% target oxygen saturation range. This can be done by giving titrated oxygen through nasal cannulae and giving the bronchodilator through an air-driven nebuliser. There is evidence from a randomised controlled trial for this approach (see Box).[9]

An alternative to nebulisation that allows for the ongoing titration of oxygen therapy is to give the bronchodilator from a metered dose inhaler via a spacer. If an oxygen-driven nebuliser must be used, the duration of each nebulisation should be limited.[3]

Patients who improve

If the patient's clinical condition improves to the extent that their oxygen saturation exceeds the target oxygen saturation range, this is an indication to reduce the concentration of inspired oxygen. Monitoring of oxygen saturations should be continued to detect subsequent deterioration of the underlying condition and the requirement to increase or resume oxygen therapy.

Patients who deteriorate

If oxygen saturations fall or increasing oxygen concentrations are required to maintain oxygen saturation within the target range, review the

Table **Oxygen-delivery devices**

Device	Oxygen delivery	Advantages
Standard nasal cannulae	24–35% FiO_2 at a flow of 1–4 L/min	Comfort, cost, easy titration
Simple face mask	40–60% FiO_2 at a flow of ≥5 L/min*	Delivery of higher FiO_2 levels than nasal cannulae
Non-rebreather reservoir mask	>60% FiO_2 at a flow of 15 L/min	Delivery of higher FiO_2 than simple mask
Venturi masks	FiO_2 set at 24–60%	To deliver controlled FiO_2, particularly at 24–28% in patients with COPD and others at risk of hypercapnic respiratory failure
High-flow nasal cannulae	FiO_2 set at 21–80%	Comfort, humidification and easy titration across a wide FiO_2 range

FiO_2 fraction of inspired oxygen COPD chronic obstructive pulmonary disease
* To avoid rebreathing of carbon dioxide exhaled into the mask

patient and consider measurement of their arterial blood gases.

In hospital a need for a fraction of inspired oxygen (FiO_2) greater than 40% should trigger a review by a senior clinician. If the patient requires an FiO_2 greater than 50%, consultation with intensive care is recommended. Increased monitoring and non-invasive or invasive ventilation should be considered.

If oxygen-induced hypercapnia develops, oxygen therapy should not be abruptly stopped. This may lead to rebound hypoxaemia (with a fall in oxygen saturation to below the level seen before oxygen was given).[14,15] Oxygen should be gradually down-titrated and non-invasive ventilation considered.

Prophylactic oxygen therapy

There are risks in the practice of administering prophylactic oxygen to a breathless patient who is not currently hypoxaemic, in the belief that it may prevent hypoxaemia if the underlying condition deteriorates. This practice has the potential to cause delay in recognising clinical deterioration and reduce the time available to start additional treatment.[16]

Conclusion

A major shift is occurring in the use of oxygen therapy. This shift is based on the recognition that the routine administration of high-concentration oxygen to acutely unwell patients has the potential to cause harm. Oxygen therapy should be titrated to ensure patients have an oxygen saturation within a target range. This reduces the risks of both hypoxaemia and hyperoxaemia. ◅

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FURTHER READING

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